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expedition, provided with forty chronometers, has to join, first, Moscow with Saratow; and then, this latter town with Astrachan; and, finally, the great trigonometrical operations in the southern part of Russia and in the Transcaucasian provinces are carried on without the least interruption. From the last-mentioned circumstance you will conclude that on our part both the astronomical and the geodetical part of a great arc of parallel will be finished in a very short time.

"In my astronomical pursuits the parallaxes of fixed stars have taken a prominent part during the last year, and I think I have made a considerable progress in these researches. Now that the methods of observations are entirely fixed, I am quite sure that if there is a difference of parallax of 0″·1 between any couple of stars situated at a distance less than 5′ from another, four observations made at the epochs of maxima and minima will be entirely sufficient to prove its existence and to define its amount within very narrow limits. I have not yet calculated exactly other parallaxes besides those of α *Lyræ* and 61 *Cygni*, the general results of which are known to you, but a short review of my observations shows that μ *Cassiopeiæ* has a parallax of more than 0″·3, η *Cassiopeiæ* of more than 0″·2, and *Capella* of between 0″·1 and 0″·2. For all these cases, the results obtained by the angles of position agree remarkably with those furnished by the distances.

"The observations of other stars, namely, of α *Tauri*, α *Aquilæ*, α *Andromedæ*, and α *Cassiopeiæ*, are about to be closed; but to guard me against any preoccupation, not even the first step has been made for the reduction of these observations."

## *The Positions of* 20 *Polar Stars, as determined at Redhill.*

By R. C. Carrington, Esq.

In the belief that the publication of the positions of an increased number of polar stars suitable for the determination of the meridian error and polar-point circle-reading of a meridian instrument, may be of general utility, I somewhat anticipate the future appearance of the catalogue I have in progress, and give at once the values I now possess, and am satisfactorily applying at Redhill.

The places here given are the result of a careful discussion of 612 observations taken (simultaneously in each element) between the months of December 1853 and April 1855 inclusive. Of these, the older established stars α, δ and λ *Ursæ Minoris*, and 51 *Cephei*, appropriate 326, leaving 286 observations to the remaining 16, the numbers of observations of which individually range from 9 to 28. The constants used in their reduction are those given by Peters in his *Num. Const. Nut.* Terms of the second order were omitted, but the small terms which have for argument twice the moon's longitude, were applied throughout. The epoch is the instant at which the sun's mean longitude was 280° near the beginning of the year 1855.

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| | R.A. | N.P.D. | | R.A. | N.P.D. |
|---|---|---|---|---|---|
| | h m s | ° ′ ″ | | h m s | ° ′ ″ |
| ... | ...... | ...... | 12 | 12 14 22·10 | 1 29 46·8 |
| 1 | 0 45 30·70 | 1 45 23·9 | ... | ...... | ...... |
| Pol. | 1 6 31·20 | 1 27 48·8 | ... | ...... | ...... |
| ... | ...... | ...... | 13 | 13 12 10·50 | 1 34 26·2 |
| 3 | 2 30 34·50 | 2 2 53·0 | ... | ...... | ...... |
| ... | ...... | ...... | 14 | 15 25 59·70 | 2 13 9·4 |
| 4 | 3 52 25·10 | 4 50 7·5 | ... | ...... | ...... |
| ... | ...... | ...... | 15 | 16 6 34·95 | 4 17 20·0 |
| 5 | 5 15 59·15 | 4 53 35·0 | ... | ...... | ...... |
| 6 | 5 48 0·40 | 3 14 26·6 | ... | ...... | ...... |
| ... | ...... | ...... | δ | 18 19 6·85 | 3 24 0·6 |
| 51 C | 6 31 6·60 | 2 44 51·3 | ... | ...... | ...... |
| 8 | 7 3 39·60 | 0 58 10·3 | ... | ...... | ...... |
| ... | ...... | ...... | λ | 20 8 29·90 | 1 7 27·4 |
| ... | ...... | ...... | 18 | 21 27 40·75 | 3 34 15·9 |
| 9 | 9 47 45·20 | 2 0 37·5 | ... | ...... | ...... |
| ... | ...... | ...... | 19 | 22 30 46·20 | 2 39 23·7 |
| 10 | 10 52 57·50 | 1 34 29·3 | ... | ...... | ...... |
| ... | ...... | ...... | 20 | 23 27 49·50 | 3 29 32·4 |
| 11 | 11 57 21·80 | 3 36 32·5 | ... | ...... | ...... |

It would too much increase the length of this communication for me to explain fully the process of discussion which has led to the positions at present adopted, but one phenomenon of observation presented itself in the course of it which I am desirous to state, as it may possibly prove to be the discovery of a source of discordance not hitherto noticed. The circumstance to which I allude is, that observations of those polar stars which are visible in daylight require (in my own case, at least), when observed in daylight, a sensible correction in both elements before they are comparable with observations taken by night, and consequently that an azimuth error, or a latitude deduced from observations of a star alternately above and below the pole, not so corrected, will generally be in error.

It is my practice, in reducing transits, to use the formula

$$c \cdot \frac{1}{15} \cdot \operatorname{cosec} \delta + m \cdot \frac{1}{15} \cdot \operatorname{cotan} \delta + n$$

The collimators provide the means of always keeping the collimation error $c$ so small, that for the region I am working upon the residual amount may be neglected as collimation error, and merged with $m$ the meridian error, given by observation; the constant $n$ being lumped with clock-error.

Now when the separate values of $m$ and of the polar-point circle-reading deduced from each star were arranged, as in the table for the latter part of August 1855, given below, it immediately became apparent, after a first approximation to the finally-adopted mean positions, that the corrections I have mentioned would be required, and that they held good with a degree of consistent uniformity which could hardly have been expected.

The mean of 36 daylight observations of *Polaris* gave an

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excess over night values of $-1''\cdot3$ in $m$, and of $+1''\cdot4$ in $p$. For *δ Urs. Min.* 24 obs. gave $-0''\cdot8$ in $m$, and $+0''\cdot9$ in $p$. For 51 *Ceph.* 19 obs. gave $-0''\cdot9$ in $m$, and $+0''\cdot9$ in $p$. The discrepant signs among the values were very few.

In practice I consequently now apply to all values of $m$ and $p$ deduced from daylight observations of *Polaris*, the corrections $+1''\cdot3$ and $-1''\cdot3$ respectively, and for *δ Urs. Min.* and 51 *Ceph.* $+0''\cdot9$ and $-0''\cdot9$.

We may, perhaps, have some difficulty in deciding between two possible sources of this discordance. Either we may suspect that the excess in $m$ indicates that the instrument has a diurnal variation of position arising from the action of temperature, and that the excess in $p$ indicates the necessity of some correction to the refraction-table used; or, secondly, we may suspect that both excesses arise from difference of optical circumstances.

In the case of my own transit-circle the annual range of $m$ appears, from the exact observations of two years, to be about 9 seconds, the greatest + values being reached at the beginning of March, and the greatest − values at the end of August; and so far the signs would agree with the idea of the difference arising from variation of temperature. But, on the other hand, the amount of these excesses of $m$ derived from observations made at very different hours in the day, and at times when the diurnal range of temperature, has been very different, will not support the notion. Further, an inspection of the series of values of $m$ deduced from frequently as many as 6, 8, and 10 stars in one night, during which the thermometer will have progressively fallen 10° or 15°, does not appear either to support the notion, there being as many nights exhibiting no progression of value as of those which may, perhaps, be thought to do so.

I am accordingly inclined, till I have better grounds for forming an opinion, to lean to the second of the possible causes before named, partly from one hypothesis in that case meeting both discordances, partly because I think this view rather supported by the brighter star *Polaris* requiring so sensibly different corrections from the fainter ones, and partly because small discrepancies thus originated are not altogether unknown to us, as might be illustrated by the history of the restoration of the standard yard.

Should this view be supported hereafter, we may, perhaps, find these corrections added to the list of personal equations.

I somewhat regret that the observations in which I am now engaged do not admit at present of my making such new arrangements as would facilitate the immediate settlement of this doubtful point, and that I have to content myself with recommending it to the consideration of those who are engaged in exact meridional astronomy.

I shall be glad if the present statement should lead any other observer to communicate anything from his experience which may elucidate the subject.

In the following table, which is added partly in explanation of

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a previous allusion, and partly to give confidence in the use of the published positions of the 20 stars, the asterisk against a star's number indicates that it was observed below the pole; the column *w* shows the number of wires over which the star was observed in R.A.; the column *t* gives the seconds resulting from time of passing mean wire + correction for clock-error + reduction to 1855·0; the column *f* contains the factors $\frac{1}{15}$ · cotan δ; the column *d* gives the number of seconds by which the seconds in column *t* are less than the adopted right ascensions; the column *m* contains the separate values of the corrections for meridian error found by dividing *d* by *f* for each star. The column *p* contains, in like manner, the seconds of the circle-reading of the polar-point given by each star. These circle-readings result from the use of a single pair of microscopes, usually read by Mr. Simmonds, but read on the 26th and 31st of August by Mr. Carrington.

| 1855. | Star. | *w.* | *t.* | *f.* | *d.* | *m.* | Apply. | *p.* | Apply. |
|---|---|---|---|---|---|---|---|---|---|
| | | | s | | s | ″ | ° ′ | ″ | |
| Aug. 21 | δ | 5 | 13·56 | +1·123 | − 6·71 | −6·0 | 359 56 | 54·9 | |
| | 51 C* | 5 | 58·84 | −1·388 | + 7·76 | −5·6 | ——— | 54·1 | |
| | 8* | 3 | 17·09 | −3·930 | +22·51 | −5·8 | | 53·5 | |
| | λ | 3 | 51·84 | +3·402 | −21·94 | −6·5 | | 53·4 | |
| | 11* | 5 | 15·85 | −1·057 | + 5·95 | −5·6 | ″<br>−5·9 | 54·6 | 54·1 |
| 26 | 8* | 3 | 18·61 | −3·929 | +20·99 | −5·4 | | 54·4 | |
| | λ | 5 | 47·83 | +3·405 | −17·93 | −5·3 | | 53·2 | |
| | 9* | 3 | 33·77 | −1·897 | +11·43 | −6·0 | | 54·1 | |
| | 19 | 3 | 54·89 | +1·437 | − 8·69 | −6·0 | | 54·4 | |
| | 10* | 1 | 46·62 | −2·424 | +10·88 | −4·5 | −5·5 | 54·8 | 54·3 |
| 28 | δ | 5 | 13·08 | +1·123 | − 6·23 | −5·6 | | 55·3 | |
| | 51 C* | 5 | 59·36 | −1·388 | + 7·24 | −5·2 | | 55·0 | |
| | 8* | 3 | 21·28 | −3·929 | +18·32 | −4·7 | | 54·6 | |
| | λ | 5 | 46·76 | +3·405 | −16·86 | −4·9 | | 54·5 | |
| | 20 | 4 | 55·77 | +1·093 | − 6·27 | −5·8 | −5·2 | 54·3 | 54·7 |
| 29 | 8* | 3 | 22·66 | −3·929 | +16·94 | −4·3 | | 55·0 | |
| | λ | 5 | 45·14 | +3·405 | −15·24 | −4·5 | | 54·1 | |
| | 20 | 2 | 55·90 | +1·093 | − 6·40 | −5·9 | | 54·8 | |
| | 11* | 5 | 17·23 | −1·057 | + 4·57 | −4·3 | −4·6 | 54·3 | 54·6 |
| 30 | 8* | 3 | 21·93 | −3·929 | +17·67 | −4·5 | | 55·2 | |
| | λ | 5 | 44·16 | +3·405 | −14·26 | −4·2 | | 55·7 | |
| | 9* | 5 | 34·69 | −1·897 | +10·51 | −5·6 | | 54·4 | |
| | 12* | 1 | 12·04 | −2·552 | +10·06 | −4·0 | −4·7 | 55·1 | 55·0 |
| 31 | 8* | 3 | 26·81 | −3·929 | +12·79 | −3·3 | | 54·8 | |
| | λ | 5 | 42·25 | +3·405 | −12·35 | −3·6 | | 54·1 | |
| | 18 | 3 | 45·92 | +1·070 | − 5·15 | −4·8 | | 54·7 | |
| | 11* | 2 | 17·83 | −1·057 | + 3·97 | −3·8 | −4·0 | 54·1 | 54·5 |

*Note.*—A comparison of the mean errors of single values of *m*, given by stars of different polar distance, does not lead to a preference of one star over another on account of its polar distance, within the limits of those contained in the present list.